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Digital radio-telemetry monitoring of San Nicolas Island foxes.
Final Report.

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Project overview

The island fox has been designated a conservation focus by the U.S. Navy. Because of the species unique evolutionary history, it is highly susceptible to threats from novel predators and disease. High fox densities on San Nicolas Island make this population particularly vulnerable to disease epidemics. Since an epidemic or novel predator can effect populations over a short time period, annual surveys and monitoring may not be enough alert managers about onset of potentially catastrophic declines.

Daily, weekly, or monthly survival monitoring of wildlife populations is typically conducted using radio telemetry. Though telemetry is quite effective, it is also quite expensive, particularly in terms of labor costs. Even the most intensive monitoring, however, is only effective if results are tied to management actions. Appropriate responses to monitoring results must balance the need to respond to real threats against the cost of false alarms. This balance is best achieved through the use of a tiered response system based on observed increases in mortalities during a short time period.

Figure 1. Remote receiving stations. (Right) Phase I station overlooking the north shore of San Nicolas Island. (Left) Phase II station overlooking west end of San Nicolas Island.

Here, we report on the second year of a project demonstrating an efficient method for tracking daily survival of a large number of island foxes. The first goal of this project is to demonstrate a labor-saving novel technology to efficiently monitor the daily survival of a large sample of island foxes. The second goal is to develop mortality thresholds which trigger increasingly intensive management response when natural mortality rates are exceeded.

In the first year of this project, we demonstrated the potential for using a set of remote receiving stations to effectively monitor a large sample of radio-collared foxes within a limited geographic scope. We placed radio-collars on 64 island foxes and monitored transmissions from those collars with a set of remote receiving stations. Every hour, the collars transmitted a Morse code signal with ID and fox status indicating if it was alive (i.e., active) or dead (i.e. collars inactive for at least 6 hours went into "mortality mode" designated by a special code) to remote receiving stations strategically placed throughout the island (figure 1). The signals were received and recorded to a digital voice recorder which was replaced every few days. The data were downloaded and translated to a text file where a single technician could note which animals were reporting in mortality mode or were missing. Those animals were then tracked using traditional telemetry techniques. Dead animals were collected and sent for necropsy.

Examples of young (top) and old (bottom) adult San Nicolas Island foxes.

Table 1. List of presentations at regional and national meetings incorporating parts of this project.

Presentation Title (Authors)	Presented at
Age Specific Mortality Patterns in Island Foxes (B. Hudgens, F. Ferrara)	7th California Island Symposium (2008)
Automated Remote Telemetry: Developing a Monitoring Plan for the San Nicolas Island Fox (F. Ferrara, B. Hudgens, D. Garcelon)	7th California Island Symposium (2008)
An Automated Monitoring System for Island Foxes on San Nicolas Island, CA (F. Ferrara, B. Hudgens, D. Garcelon)	Sustaining Military Readiness Conference
Annual Update on San Nicolas Island Foxes (G. Smith)	Island Fox Meetings (2008)
Automated Telemetry System for Monitoring Island Foxes (D. Garcelon, B. Hudgens)	Island Fox Meetings (2007)
Automated Remote Telemetry: Developing a Management Plan for the San Nicolas Island Fox (F. Ferrara, B. Hudgens, D. Garcelon)	Society for Conservation Biology Annual Meetings (2008)

We discovered a few shortcomings of the system used in the first year including: signal mistranslations, false mortalities, and antennae breaks on radio collars. Signal mistranslations were caused by interference resembling the Morse code sent by the radio collars, occasionally leading to false "live" check-ins. False mortalities were caused by animals resting longer than six hours, triggering the mortality signal in their radio collar. Hourly status reports meant that receiving stations were more likely to record mortality signals from long-resting animals than would be the case if conducting once daily checks using traditional telemetry methods. In addition, there were several collars that did not reset when the animal later became active. The vigorous activity required to reset collars once they were in mortality mode was a deliberate choice to prevent scavengers from moving a fox carcass and thus resetting a collar on a dead animal to "normal" mode. Antennae breaks were caused by a weak spot where the antenna emerged from the collar, causing them to break after several months of wear. Consequently, signals carried only a short distance and foxes were reported as "missing" before the end of the scheduled collar life. The second phase of the project addressed these issues.

The first phase of this project demonstrated, for first time, higher mortality rates in the oldest age class of foxes. Previously, adult survival rates have been assumed to be constant regardless of fox age. These results were presented at several professional meetings (table 1) and were incorporated into National Park Service monitoring and management guidelines for endangered populations on federal lands.

Based on our results from phase 1, we recommended a monitoring protocol and response triggers that assumed no temporal pattern in mortality (tables 2-3). There was, however, one period with an exceptionally high mortality rate, accounting for four of the ten total mortalities of monitored foxes. The recommendations from the first phase may be further limited because they are based on a sample from a small portion of the island, which may have had skewed mortality patterns compared to the island as a whole.

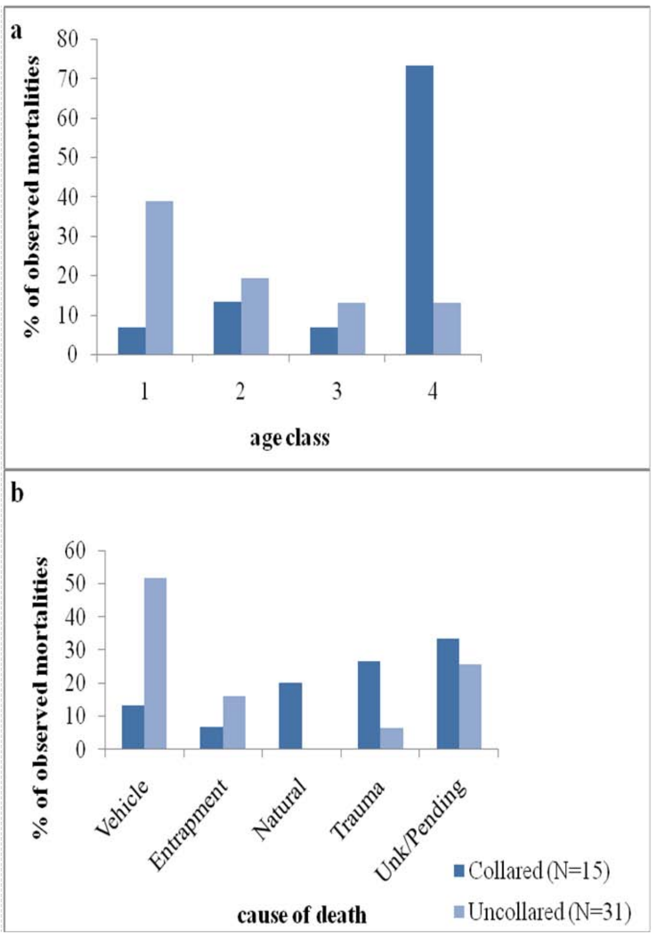


Figure 2. Age class distribution (a) and cause of deaths (b) of observed mortalities of collared and uncollared island foxes from July 2006-March 2008.

Differences in spatial mortality patterns can be inferred from comparing collared animals to reported mortalities of uncollared animals. While mortality rates of collared foxes were greater in older animals, and caused by a variety of mechanisms, reported mortalities of

uncollared adults were greatest for the youngest adult age class and almost exclusively a direct result of vehicular trauma (figure 2). These differences are largely due to the fact that reported mortalities of uncollared foxes were of animals found near roads or buildings, while collared animals were monitored at a wider variety of distances from roads and buildings reflective of the landscape on the western third of the island. That is, most mortalities that occur near roads were caused by vehicular trauma, although vehicular trauma is not the major mortality source island-wide. In phase II of project we expanded our ability to examine spatial and temporal variation in mortality rates.

New in phase II

The primary improvements implemented in the second phase of this project involved changes to the telemetry system. The most significant improvement was a switch from receiving stations that only recorded Morse code signals to those that translated the signals and digitally relayed them to a central computer. Although the original receiving stations were more portable than the phase II stations (figure 1), the phase II relay stations afforded greater spatial coverage, efficiency, and improved data quality. The relay stations also allowed collared foxes to be monitored off-site so that daily survival checks could continue even when staff was not present on the island.

Other improvements included longer ID codes that avoided problematic letters (particularly “e” and “i”) to minimize the possibility of false live check-ins, software to streamline data processing and prevent false signals (i.e., ID codes not corresponding to a collared fox), more sensitive triggers to reset collars in mortality mode to reduce false mortality signals, and reinforced antennae to prevent breakage. We describe the phase II monitoring system in greater detail in the following section.

Table 2. Trigger points and management actions in response to high mortality of monitored foxes.

Response[1]	Trigger point[2]	Actions
Category 1	A	*Rush carcasses for necropsy within 24 hours to determine cause of death
Category 2	B	*Initiate vaccination against most likely disease threats (canine distemper and rabies). *Set up trapping grids away from mortalities while getting vaccines onto island. *Begin trapping and inoculating animals until threat abated.
Category 3	C	*Initiate capture and seclusion of healthy foxes and captive breeding program. *Immediately prepare quarantined captive holding facility on island and trapping foxes away from mortalities. *Captured foxes should be tested for disease and held in separated cages until determined to be disease free. *Continue capturing healthy animals until disease threat is abated or a total of N animals representative of the population are captured.

[1]Response is triggered if the number of unexplained mortalities in a 30-day period exceeds the trigger point.

[2]The number of mortalities of collared foxes observed within a 30-day period in different age classes or of collared and uncollared foxes in different age classes corresponding to these trigger points is presented in table 3.

Table 3. The number of mortalities observed within 30 days of collared foxes in different age classes or of collared and uncollared foxes in different age classes triggering responses presented in table 2.

Observed population (number of foxes)	Expected mortalities in 30 days[1]	A	B	C
minimum collared age class 1-3 (55)	0-1	2	3	4
minimum collared age class 4 (5)[2]	0-1	2	2	2
maximum collared age class 1-3 (90)[3]	0-1	3	4	5
maximum collared age class 4 (10)[3]	1	2	3	4
island-wide age class 1-3 (570)[4,5]	2-3 (0-1)	7.9(2.4)	11.4 (3.5)	14.6 (4.5)
island-wide age class 4 (160)[4,5]	11 (0-1)	17.5 (0.9)	24.5 (1.2)	31.3 (1.6)

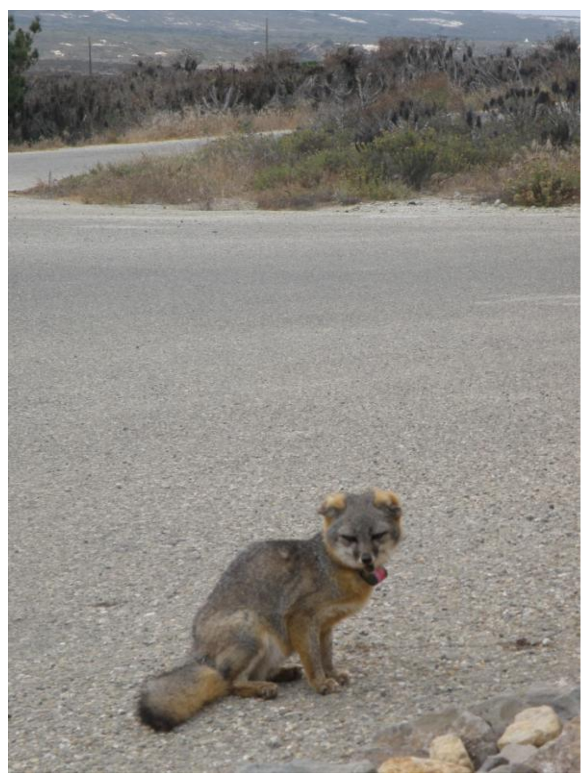
1. The expected number of mortalities during 30 days in the observed population given its mean daily mortality rate.
2. Trigger points for a monitored population of 5 age class 4 are provided for reference only. We recommend monitoring 10 age class 4 animals to allow for a tiered response.
3. Triggers are based on the upper 90% (A), 99% (B) and 99.9% (C) confidence limits of the expected number of mortalities in the monitored population calculated from phase I. Note that additional data from phase II greatly reduces the confidence intervals.
4. Assumes island-wide population of 570 young adults (age classes 1-3) and 160 old adults (age class 4).
5. Numbers represent the upper 90% (A), 99% (B) and 99.9% (C) confidence limits of the expected number of mortalities in the population. Numbers in parentheses represent the corresponding expected number of reported mortalities if there is a 31% chance of finding a dead uncollared fox age class 1-3 and 5% chance of finding a dead uncollared fox age 4.

Methods and materials

Phase II Telemetry System

The telemetry system employed in phase II of this project relies on Morse code ID signals transmitted from radio-collars to remote receiving stations and digitally relayed to a central computer. This system differs from traditional telemetry in two fundamental ways. First, traditional telemetry systems use multiple transmission frequencies to monitor multiple animals. In other words, the frequency is used to identify each individual. This limits the number of animals that can be monitored in a geographic area to prevent the bleeding of signals across frequencies. In contrast, our system relies on transmitters operating on a single frequency and sending a Morse code signal to designate animal IDs greatly increasing the number of animals that can be monitored simultaneously.

Furthermore, traditional telemetry receivers can only listen for one signal at a time, and although scanning receivers can rapidly check a large number of frequencies, their effectiveness depends on collars with near constant (i.e., several times/minute) signal transmissions. In contrast, our remote receiving stations were constantly listening to the single frequency used by all of our collars. Consequently, as long as an animal was within range of a receiving station, any signal sent by the collar would be received, so that daily survival monitoring could be achieved with only a few signal transmissions each day. Reduced transmission



frequency lowers battery requirements, allowing greater signal power and longevity from smaller transmitters.

The phase II system has several differences from the phase I system. First, although the collars transmitted the same kind of Morse code ID signal in both phases, phase II collars used a three letter code instead of two letter code. The longer code reduced the chance that interference would be mistranslated into a legitimate code, reducing the frequency of false live check-ins. Phase II collars also featured reinforced antennae and more sensitive triggers to reset collars from mortality mode. Third, phase II receivers digitally retransmitted signals with a time stamp. Fourth, data were eventually transmitted to a centralized computer, with software that verified signal IDs and eliminated false transmissions. Finally, processed data were forwarded to secure server for internet-based access, allowing real-time monitoring of fox status.

Monitoring protocol

We placed radio-collars on 62 adult foxes between July and October 2007. Because of permitting issues with the U.S. Navy, receiving stations could not be activated until October 2007. Collars were distributed relatively evenly among three trapping grids spread across the island (figure 3). Redeye and Tufts grids cover the area monitored in phase I of this project and supported the highest fox densities on the island (Garcelon and Hudgens, 2008). These grids are comprised primarily of dunes and sage scrub habitats, respectively. The final area included in our study, Skyline grid, is located 2.5-5 km SE of Tufts in primarily grassland habitat and supported relatively low densities of foxes (Garcelon and Hudgens, 2008).

Collars transmitted ID signal via Morse code approximately every 3 hours and a standard VHF telemetry signal on a unique frequency for 30 seconds every 2.5 minutes to allow tracking of missing animals. Most foxes were recorded multiple times and from multiple stations each day. However, not every signal transmitted from every collar was received. For example, if a fox

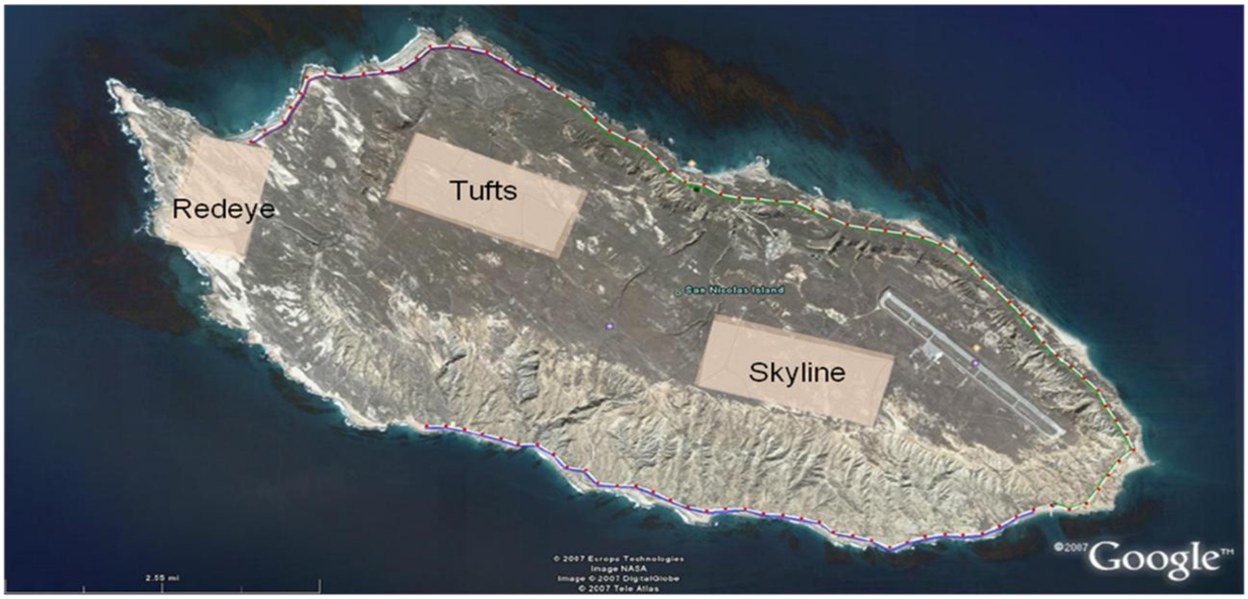


Figure 3. Map of San Nicolas Island showing trapping grids where collars were placed on foxes between July and October, 2008.

traveled to part of the island (particularly along the NE and SE coastline) with very rugged topography, or was in a deep gully or behind a large sand dune, the signal could have been blocked from reaching receiving stations.

Collars remaining still for more than 6 hours switched into mortality mode, indicated by a "??" preceding their ID code. Each collar also sent a steady VHF signal at 40 beats/minute when it was in mortality mode. If a fox with a collar in mortality mode moved, the collar would be reset to "live" mode. In some

cases, collars were stuck in mortality mode (see below) but movement was inferred from patterns of stations receiving the signals. Any animal in mortality mode for 24 hours was tracked using the traditional VHF telemetry signal. If dead, any pertinent information was noted and the carcass was collected and sent for necropsy. If alive, the fox was tracked every few days to monitor status. Attempts were also made to locate animals not checking into the system for more than 4 days.

Results

System performance

A total of 79,894 detections representing 68,614 unique check-ins (i.e., not duplicated by multiple stations) were recorded between October 2007 and August 31, 2008 (figure 4). Total monitoring effort was 12,214 fox-days.

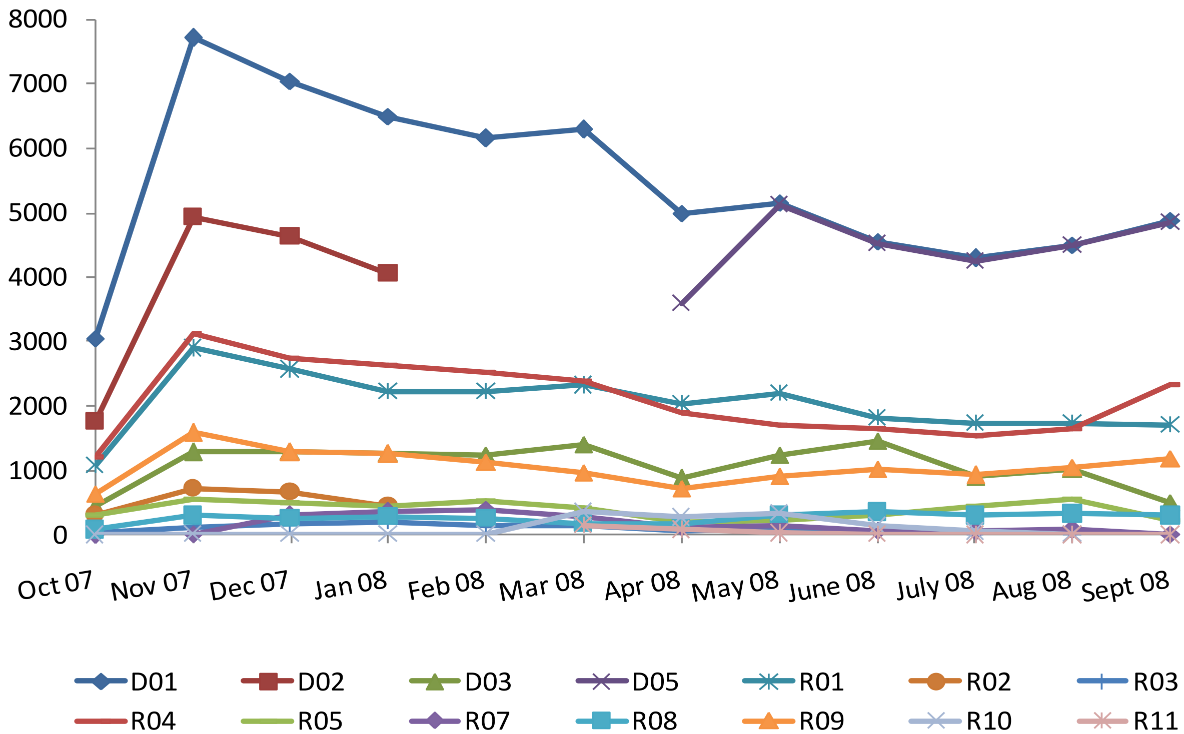


Figure 4. Numbers of signals per month received from remote receiving stations (R01-R11) and transmitted through digipeaters (D01-D05) through time. Note: Digipeater D02 was taken out of operation in January 2008 and digipeater D05 began operating in April 2008.

This year we again had a number of collars go into "mortality" mode despite being on active animals. A total of 57 collars sent at least 1 signal in "mortality" mode (figure 5), including 49 on live animals and 8 true mortalities. We worked with the company developing this system (Communications Specialists Inc.) to eliminate false mortalitie s and replaced collars with improved ones that operated without further problems.

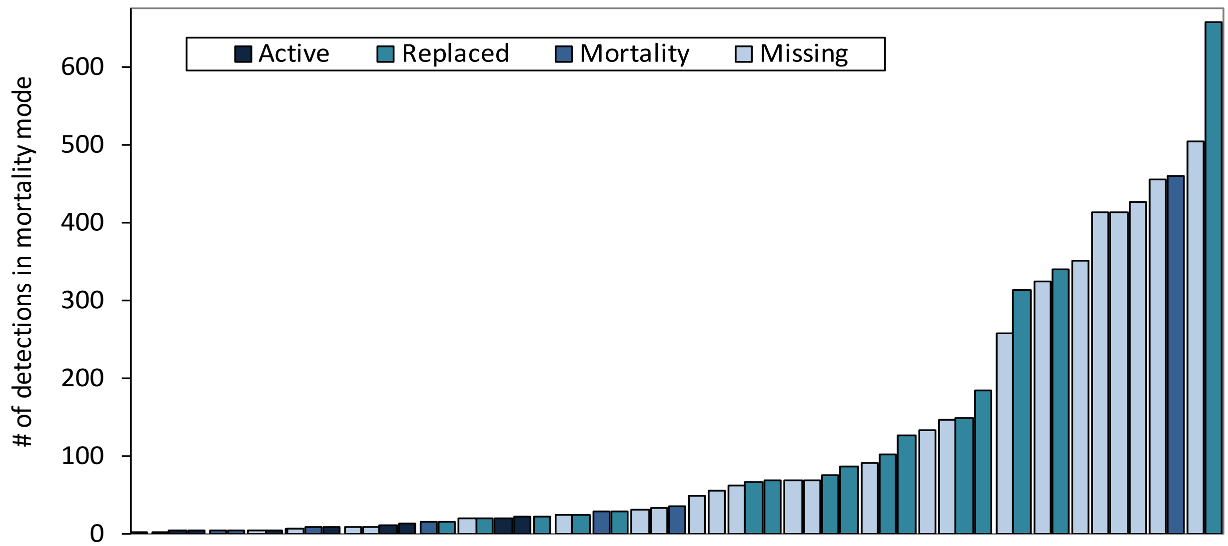


Figure 5. Status of collars reporting in "mortality" mode. Each bar represents an individual collar that reported in mortality mode at least once. Collars are ordered along X-axis by the number of mortality signals received by each collar before it was inactivated, which is indicated by the height of the bar. Collars were inactivated from mortality mode by live foxes resuming activity (Active), removal from dead foxes (Mortality), removal from live foxes (Replaced), or drained battery from foxes no longer monitored (Missing).

There were a total of 14 mortalities, since the Phase I report, 11 of which occurred since Phase II system was set up. Two mortalities were picked up by Phase I receivers, and 8 mortalities were detected by phase II receivers. Four mortalities were not detected by our system: 1 animal that died in concrete vault from which signal could not escape, 2 animals that died from vehicular trauma and were retrieved within few hours, and one animal that had been missing for 3 days which was discovered when the VHF mortality signal was heard from a truck-mounted receiver.

.Age specific survival

Overall, fox survivorship in 2007-2008 was similar to 2006-2007 (figure 6). Age-specific survival was also similar to 2006-2007, with older animals facing a significantly greater mortality risk than young adults (figure 6). The mean survivorship over the two years of this project was 0.91 for young adults and 0.42 for age class 4 adults (figure 6). Assuming foxes

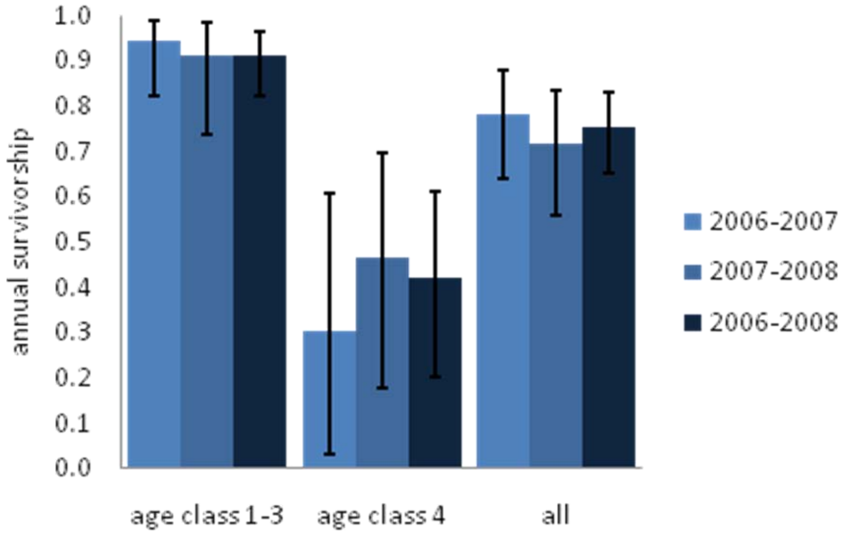


Figure 6. Age class specific survivorship of adult San Nicolas Island foxes from 2006-2008.

captured during 2007 annual trapping represent the island-wide age structure, the mean adult annual survivorship of SNI foxes from 2006-2008 was 0.80.

Mortality

As was the case in phase I, collared young adults that died were killed directly by human activity, while multiple factors contributed to the deaths of old adults (table 4). Unfortunately, two of the three younger adults killed in the past year died while we had no staff on the island, and could not be recovered for several days. By the time these two were recovered, the bodies were too decomposed or scavenged to reveal possible health issues that may have ultimately contributed to their demise. However, in one case, the proximate cause of death was clearly vehicular trauma.

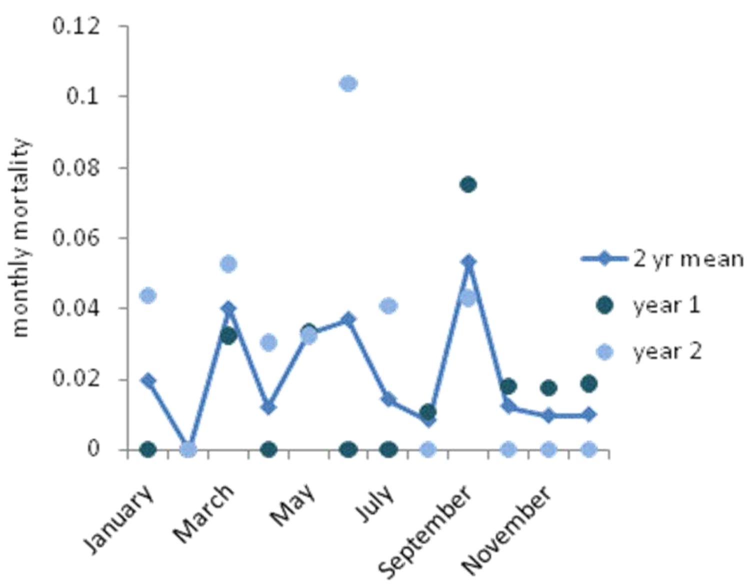


Figure 7. Monthly mortality rates from first and second years of this study. Line indicates average mortality for each month over both years.

Table 4. Fox mortalities of collared study foxes between March 1, 2007 and September 30, 2008, and their cause of death.

Fox ID	Sex	Age Class	Mortality Date	Date Retrieved	Cause of Death	Other comments
TAU	F	4	3/29/2007	3/31/2007	Emaciation	Due to metastic neoplasia
TDW	F	4	5/21/2007	5/22/2007	Lymphoma	
TEW	F	2	5/1/2007	6/2/2007	Electrocuted	
TAS	M	4	9/11/2007	9/11/2007	Vehicular Trauma	Considerable loss of functional kidney parenchyma. Extensive Spirocerca lesions.
CDL	M	2	9/22/2007	10/5/2007	Unknown	The advanced decomposition precludes determining the cause of death. Absence of fractures does not rule out vehicular trauma.
OPG	M	4	1/10/2008	1/28/2008	Pending	Not vehicular trauma (COD pending histopathology). No adipose stores are present, and the muscles are atrophied.
FGH	M	4	1/10/2008	2/10/2008	Vehicular Trauma	Presumptive
CDJ	M	3	3/19/2008	3/21/2008	Vehicular Trauma	Too decomposed/scavenged for further analysis.
MNF	F	4	3/29/2008	3/29/2008	Vehicular Trauma	
FGA	M	4	4/8/2008	4/11/2008	Unknown	Open pending histopathology (Not vehicular trauma)
DFH	F	4	5/31/2008	6/2/2008	Vehicular Trauma	
NOK	F	4	6/3/2008	6/5/2008	Unknown	Open pending histopathology (Not vehicular trauma)
DFJ	M	4	6/22/2008	6/4/2008	Euthanized due to neurological signs	The right tibia is fractured (presumed post-mortem). The small intestines contain abundant Mesocestoides. Spirocerca. Three dark red soft nodules in the jejunum mesentery. Kidneys have numerous irregular pits.
FGL	F	4	6/23/2008	6/26/2008	Unknown	Open pending histopathology (Not vehicular trauma)
GHB	F	4	7/10/2008	7/15/2008	Unknown	Advanced decomposition precludes determining the cause of death. No fractures to suggest vehicular trauma, but blunt trauma cannot be ruled out. Emaciated but feces present in the colon indicate recent feeding. Long toe nails suggest recent inactivity.

Mortality rates (m) were similar for both years of this project (year 1: m=0.22 95%CI=0.12-0.36; year 2: m=0.28 95%CI=0.16-0.44). Monthly mortality rates ranged from 0

(February: 0 mortalities in 2644 fox-days monitored) to 0.053 (September: 6 mortalities in 3285 fox-days monitored). This variation did not reflect a pattern of significant intra-annual variation in fox mortality risk (logistic regression p=0.26; figure 7).

Refined recommendations

Since mortality rates were similar across and within the two years of this investigation, we make only minor changes to the recommended monitoring strategy developed during phase I. We recommend monitoring of 100 foxes, with 90% of monitored population comprised of young (age class 1-3) adults. Successively more intensive responses would be triggered by 2 or more unexplained mortalities within a 30-day period (tables 2-3).

Management responses should also be triggered by unusually large numbers of reported mortalities of uncollared foxes. Based on island-wide population estimate of 731 foxes (Garceon and Hudgens 2008), expected number of monthly mortalities for uncollared foxes is (0.78 proportion foxes age class 1-3*730 adult foxes*.007 monthly mortality rate=) 4 young adults and (0.22 proportion foxes age class 4*730 adult foxes*.069 monthly mortality rate=) 11 old adults. From October 2007-September 2008 there were 15 reported deaths of non-collared adult foxes, one of which was an age class 4 individual. These numbers imply that there is an approximately 31% chance that the mortality of a young adult, and 1% chance that the mortality of an old adult will be discovered and reported. Based on estimates of the number of young and old adults presently on San Nicolas Island, and the likelihood of discovering and reporting the death of an uncollared fox, we recommend that two or more unexplained deaths of uncollared foxes reported within 30 days trigger the management actions presented in table 2.

We also refine last year's monitoring recommendations with respect to the composition of vaccinated vs. unvaccinated animals in the monitored group. Based on recommendations from the Fox Recovery Group, a core group of scientists and managers working to recover listed

subspecies of Island Fox, the Navy is vaccinating 80 foxes on both San Nicolas and San Clemente Islands against rabies and canine distemper. We suggest that a core group of monitored foxes remain unvaccinated to ensure rapid detection of these diseases should they reach the islands. This core group should be comprised of 55 young adults and 5 older adults, corresponding to the minimum monitoring effort we recommend. Additional monitored foxes, up to the optimal 100 animals, may be either vaccinated or unvaccinated. Monitoring vaccinated animals serves two purposes. First, it increases the chance that island invasion by other pathogens or novel predators is detected rapidly. Second, it provides a mechanism to test the efficacy of these vaccines in island foxes, which has not yet been directly demonstrated.

The final stage in this project will be to provide specific response suggestions based on a spatially explicit epidemiologic model. The model will incorporate data collected on island fox movement to accurately assess dispersal and contact rates, as well as disease spread data culled from a rich literature on the subject. The model will be used to explore the effectiveness of different vaccination and trapping strategies to minimize the impact of a virulent disease on island foxes, as well as provide a framework for exploring such problems for other species managed on federal lands.

Acknowledgements

We would like to thank Grace Smith for her support and help in carrying out the work described in this report. We would also like to thank the many other Navy personnel who helped us coordinate our efforts, and kept us safe and sane. We thank Communications Specialists for their help setting up and trouble shooting the telemetry system. Finally, we are grateful for funding support from the DoD Legacy program, project 07-308.

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Garcelon D.K. and B.R. Hudgens (2008). Island Fox Monitoring and Demography on San Nicolas Island- 2007 Final Report. Unpublished report prepared for the U.S. Navy by the Institute for Wildlife Studies, Arcata, CA. 28 pp.

Appendix 1. *Example Report for two foxes from 1700 September 29, 2008 to 1700 September 30, 2008.* The table below shows an example report of the check-in activity two animals over a 24 hour period. An "X" in the columns labeled D01 through R09 indicate which digipeaters (D##) and repeaters (R##) received each check-in. Both animals were active. The singular check-in by fox RUA received by station R05 at 22:44 suggests that the animal is moving. A mortality signal would have been indicated by a "??" preceding the 3 letter ID code (e.g. "??RUB" instead of "RUB").

ID	DATE	TIME	D01	D03	D05	R01	R04	R05	R07	R08
RUA	9/29/2008	1707	X		X	X				
RUA	9/29/2008	1953	X		X	X				
RUA	9/29/2008	2244	X		X	X		X		
RUA	9/30/2008	425	X			X				

ID	DATE	TIME	D01	D03	D05	R01	R04	R05	R07	R08
RUB	9/29/2008	1802	X		X					X
RUB	9/29/2008	2036	X		X					X
RUB	9/30/2008	150	X		X					X
RUB	9/30/2008	427	X		X					X
RUB	9/30/2008	703	X		X					X
RUB	9/30/2008	935	X	X	X					X
RUB	9/30/2008	1207	X		X					X
RUB	9/30/2008	1438	X		X					X

Appendix 2. *Rough estimate of cost to monitor daily survivorship of 100 foxes using traditional telemetry and automated telemetry system.*

Below is a preliminary estimate of what it would cost the Institute for Wildlife Studies to monitor the daily survival of 100 foxes using traditional telemetry methods and the automated telemetry system demonstrated in this project. The costs assume that collars are placed in four areas trapped by two trained technicians for two days with one day to set up each area. This is probably an optimistic scenario if trapping cannot be combined with annual monitoring. We further assume that it requires two people to get daily survival checks on 100 animals using traditional methods, and that it takes one person an hour each day to check online report. We assume that these times are sufficient to cover all data management and reporting duties as well. We budget for a person from our Arcata office to spend two days/month searching for foxes in mortality mode if the automatic telemetry system is used, although the expectation is that monthly mortality rates will be high enough to trigger carcass collection for necropsy only a few times each year (in fewer than five cases would this have occurred in the last two years based on

the recommendations presented here). Personnel costs reflect the total costs of trained fox technicians except for housing on San Nicolas which is assumed to be $30/night. For simplicity, costs associated with senior staff (e.g., project managers) have been omitted and all work is assumed to be carried out by technicians. It should be noted that the costs of remote receiving stations and digipeaters has not been set yet by the company that is developing them, and the figure presented here is only a preliminary estimate.

Item	Traditional Telemetry Cost	Automatic Telemetry System Cost
Receivers	2@$800 ea.=$1600	2@$800 ea.=$1600
Receiving Stations (year 1)	0	5@$5000 ea. =$25,000
Collars year 1	100@ $250 ea. =$25,000	100@ $250 ea. =$25,000
Trapping effort to place collars (year 1)	$5,800	$5,800
Personnel to monitor collars	2 full time staff=$97,000	1/8 full time staff=$6,000
Personnel to retrieve dead animals	(included in monitoring staff)	2 days/month=$4500/year
Total personnel cost	$97,000	$10,570
Vehicle cost	$21,600	$800
Housing costs	$21,900	$750
Transportation costs (From Arcata to SNI)	$0	$9,600
Total Year 1	$172,900	$79,120
Collars years 2+	100@ $250 ea. =$25,000	20@$250 ean. =$5000
Trapping effort to replace collars (yrs 2+)	$5,800	$1,600
Personnel to monitor collars	2 full time staff=$97,000	1/8 full time staff=$6,000
Personnel to retrieve dead animals	(included in monitoring staff)	2 days/month=$4500/year
Total personnel cost	$97,000	$10,570
Vehicle cost	$21,600	$800
Housing costs	$21,900	$750
Transportation costs	$0	$9,600
Total Year 2	$171,300	$28,320
5 Year Total	**$858,100**	**$192,400**